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AUTHOR Thompson, Patricia J.
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ABSTRACT

Most educated women (in the sciences and other fields) still have a hard time discarding the patriarchal socialization and pressures in their own fields which prevent them from seeing this extraordinary woman as an environmental pioneer and ecological foremother. Ellen Swallow Richards merits attention and respect as a foremother of what would become the environmental movement, perhaps even foreshadowing ecofeminism. Richards' scientifically-grounded environmentalism was the outgrowth of "Yankee frugality," of lessons learned as the classically educated daughter of a small-town farmer and storekeeper, of her exposure to astronomer Maria Mitchell as a role model during her collegiate years at Vassar, of her ongoing research at MIT in air, water, soil, and food, and of her work as an industrial chemist and women's educator. Her efforts can be compared to the efforts of contemporary women scientists and feminist scholars to reconceptualize the sciences. (LZ)

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ELLEN SWALLOW RICHARDS (1842-1911): ECOLOGICAL FOREMOTHER

Patricia J. Thompson
Lehman College, CUNY,
The Bronx, NY, 10468

Wholeness demands its own rigour -- its own standards.
-- Marcuse

"Ecology" entered my consciousness long after I had graduated from college and, in fact, after I had read the books of Rachel Carson. "Ecology" was discussed as a "new" perspective in the late 1960s and early 1970s when I was an editor in scholarly and textbook publishing houses. It entered my thinking at the same time as "systems" theory, and the two clicked for me as a long-sought way to understand my own experiences and observations. I have used the ecological perspective in writing and editing textbooks since 1973. When I first taught as an adjunct in a college Home Economics program, I had never heard of Ellen Richards, recognized as the field's "founding mother." Her biographer calls her "The Woman Who Founded Ecology" (Clarke, 1973). In his concluding paragraphs, Clarke said:

> It is not strange that a woman founded environmental science and formulated a solution to a crisis she saw building, any more than it is strange that a later woman, Rachel Louise Carson, would be credited with reawakening public interest in the crisis long after [Richards] was gone and forgotten .... (255)

Certainly Ellen Swallow Richards merits our attention and respect as a foremother of what would become the environmental movement, perhaps even foreshadowing ecofeminism.

I will argue that Richards' scientifically-grounded environmentalism was the outgrowth of "Yankee frugality," of lessons learned as the classically educated daughter of a small-town farmer and storekeeper, of her exposure to astronomer Maria Mitchell as a role model during her collegiate years at Vassar, of her ongoing research at MIT into air, water, soil, and food, and of her work as an industrial chemist and women's educator. I will also make some comparisons with efforts being made by contemporary women scientists and feminist scholars to reconceptualize the sciences.

Paper prepared for "Think Tank" session, "The Wisdom of the Elders" sponsored by the SIG Ecological/Environmental Education at the Annual Meeting of the American Educational Research Association, New Orleans, LA, April 5, 1994.

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Foremothers: A Feminist Issue in the History of Science

The November, 1993 issue of *Scientific American* displayed a period photograph of the twenty-five men and one woman who constituted the chemistry faculty of the Massachusetts Institute of Technology in 1900. In the front row sits a diminutive woman (I am tempted to say "birdlike"), with a clear gaze, hands folded in the lap of her Victorian dress with its elegant silk details. She sits with her colleagues -- among them but not of them. She appears to be a focused bundle of energy, looking not at the camera but at some distant future. Those who knew her would say that she burned with a determination to open science to women and to use science for the betterment of the human condition. She was Ellen Henrietta Swallow Richards (1842-1911), the first woman to serve on the faculty of MIT.

Spanier (1991) says that despite "a history of feminist concern about science as a white male-dominated endeavor that exerts control over all aspects of women's lives, relatively few .... have overcome the socialization and pressures of their profession to bring a radically feminist perspective to their own fields." (167). I will suggest that, in fact, Ellen Swallow Richards endeavored to provide scientific thinking and scientific information to empower women in all aspects of their daily lives. Most educated women (in the sciences and other fields) still have a hard time shaking the patriarchal socialization and pressures in their own fields which prevent them from seeing this extraordinary woman as an environmental pioneer and ecological foremother.

Nature and Necessity

The adjectives "hardy" and "solid" are often applied to the character of early New England settlers. Ellen Swallow-Richards was these -- and something more. She was a scientist, educator, environmentalist, consumer advocate. She was a friend to women whose career defies being pigeonholed in a single patriarchal category. In most of what she did, she was the "first woman" to do so. The seventh generation of Swallows, she was the last of a line that emigrated from England before 1666. Her mother's family had come even earlier. Her parents, Peter and Fanny Swallow, were Academy-educated, which was unusual for their time. Both had been teachers before their daughter was born. After her birth, Ellen's mother suffered from chronic illness and was often bedridden. Ellen assumed caretaking and homemaking responsibilities on the family farm in New Hampshire where, Clarke says, she began her "lifelong pact" with nature (6).

For her first sixteen years, Ellen Swallow was educated by her invalid mother and her farmer father. She spent so much time outdoors that her mother feared she might become a "tomboy." At seventeen, she was sent to Westford Academy where she received the same classical curriculum -- including Greek and Latin -- that prepared young men for Harvard College. Later, when her father became the proprietor of a general store in a small town, she helped him in his business and was remembered as a bookish girl who also managed the post office substation. After graduation from the Academy, Ellen "hired out" as a teacher, tutor, nurse, and cook, and she cleaned other peoples' houses to earn funds for her college education. Education -- not matrimony -- was her goal. She stood out early for her independence of mind. She wrote her observations of married life to her cousin:

> the silent misery I am discovering ... among my friends whom I thought happy ... makes me shudder. Some things I learned yesterday ... almost made me vow I would never bind myself with the chains of matrimony .... girls don't get behind the scenes as I have, or they could not get up such an enthusiasm for married life. (12)

Her reference to women's "silent misery" and to the "psychosis of negation" (79), I would claim, were 19th century equivalents of Friedan's "feminine mystique" and these insights mark Richards' empathy with women's oppressed condition. There is no question that she saw the need for a wholesome, healthy, life-affirming environment as a woman's right.

In the 1870s, it was generally believed that education was detrimental to women. Clarke writes that "The 'old maid' or 'spinster' stereotype of an educated woman was widely held. Uneducated men feared her; married women shunned her. Educated men weren't sure." (84)

Eisenberg (1992) offers a graphic account of the misogynist attitudes that placed serious obstacles in the path of any woman with the temerity to propose a career in science:

> Nineteenth-century neuroanatomists and craniologists ... diligently measured and weighed female brains to prove women lacked a talent for the hard task of scientific reasoning. Sir David Brewster, Newton's biographer, announced that "the mould in which Providence has cast the female mind, does not present to us those rough phases of

> masculine strength which can sound depths, and grasp syllogisms, and cross-examine nature." (96)

As Eisenberg emphasizes:

> Women were sternly warned that any effort to hone their inferior brains, particularly in science, would lead to damage both to themselves and to their unborn children. "Over-activity of the brain during the critical period of the middle and late teens will interfere with the full development of mammary power and the functions essential for the full transmission of life generally" .... (96)

Such were the prevailing social attitudes even among men who were courtly and gallant toward women in social situations. Ellen confronted these attitudes with tact and determination in the course of obtaining an education and pursuing a career in science. Women who pursued education were said to contravene the "laws of nature" which prescribed for them the role of mother and housewife. Ellen saw nothing incompatible between the activities of the home environment and those of the natural environment. In fact, the two were linked, and knowledge of this connection, she would insist, should be reliable, based on science, not on superstition.

It was surely in patriarchy's interest to keep women out of science as a way to preclude challenges to their "woman's intellectual inferiority" hypothesis. What better way to avoid challenges to their assumptions than to keep women out of institutions of higher learning and out of scientific laboratories? Not very "scientific", I would say!

Ellen Swallow was already 26 years old when, having saved $300 from various employments, she enrolled at Vassar College as a "special student" (15), what we might today call an "advanced placement." Her career at Vassar was marked by the mentoring of A.C. Farrar, head of the Department of Natural Sciences and Mathematics, and Maria Mitchell, her astronomy instructor, the first woman to hold such an appointment in an American college. At Vassar, Ellen majored in chemistry, but she made the outdoors her laboratory as well, developing and maintaining an interest in the chemical properties of soil, air, and water. She helped to support herself by managing the rooming house where she lived. Her first-hand experience of household management throughout her childhood, youth, and adulthood were undertaken in a positive spirit. After two years of study, Ellen Swallow graduated from Vassar in 1870 with an A.B. in chemistry. She was determined to pursue her

scientific calling. Ellen Swallow spent almost two years looking for an opportunity to pursue advanced studies in science after her graduation from Vassar in 1870.

Bacon's "New Paradigm" for Science

By the time Ellen Swallow graduated from College, a "scientific community" was already well established. The foundations of modern science were laid down by the English statesman-philosopher Sir Francis Bacon (1561-1626) who rejected the prevailing idea that day-to-day existence was too brief and too brutal to be worthy of serious attention. He joined science to philosophy and so paved the way for the 17th century Age of Reason and the 18th century Enlightenment. In *Novum Organum* (1620) he urged scholars to turn from the authority of Aristotle to the evidence of their senses. Bacon addressed his work to the "true *sons* of knowledge," summoning them to woo "female nature's secrets" and to impose male "order and reason" on her "mysteries" (Eisenberg, 1992, 96). In *The New Atlantis* (1627) Bacon proposed a scientific workplace ("Salomon's House") with the goal of using tested knowledge for the betterment of human life. According to Budewig (1964):

> [t]he one thinker who, more than any other, was able to articulate the concept that man's life on earth was possible of improvement was Francis Bacon. No one before Bacon had ever considered the everyday things of human existence worthy of study or that the study of them could better human welfare. The "true end" of knowledge, he said, was "for the benefit and use of life." To Bacon we therefore owe the first and most forceful philosophical justification for a science of agriculture, industry, and home living that had ever been given.
>
> With the observation that knowledge should benefit the human condition, Bacon completely reversed a mode of thought that had dominated the affairs of men for two thousand years. That the things of earth and human life were worth knowing, or that they could be changed, or that man's lot could or should be improved were completely new ideas in the history of thought.

In his design for a "normative science," Bacon differed from Descartes (1596-1650) whose method stressed objectivity and increasing dependence on quantification and mathematical operations for the testing of hypotheses. His ideal of a "values free" science, some feminists would argue, conceals an androcentric bias and a "flight from the feminine"

(Bordo, 1987). According to Bordo (1986), the development of Cartesian objectivism (and modern science in general) demonstrates the masculinization of thought, which she describes as the "cultural drama of parturition." Thus the 17th century nurtured a "scientific revolution" marked by a paradigm shift from the a priori approach of the scholastics to what we today call "scientific rationalism" embodied in the "scientific method." It was a transition from an organismic to a mechanistic world view, a crucial shift that Merchant (1980) characterizes as the "death of nature."

Keller (1982) acknowledges a "dual theme" pervading the work of all scientists in all ages that is evident in the competing conceptualizations of science as "dominating" and as "conversing with" nature (244). The competition is expressed in theories that support hierarchical rather than nonhierarchical views of biological organization. There are two opposing standpoints on order -- one imposed, the other emerging as a necessary component of the maintenance of system equilibrium. In her view, "the impulse to domination does find expression in the goals (and even in the theories and practice) of modern science," and she argues that "where it finds such expression the impulse needs to be acknowledged as projection" (242). She asks:

> Under what circumstances is scientific knowledge sought for the pleasure of knowing, and for the increased competence it grants us, for the increased mastery (real or imagined) over our own fate, and under what circumstances is it fair to say that science seeks actually to dominate nature? (241; Keller, 1982; 1987)

To what extent has knowledge of physical and social nature been used to diminish and dominate the generalized experience recognized as "human nature?" In Ellen Richards' writing and in her life we see a dedication to science as a means of empowerment ("increased mastery") for women. While suffragists saw the ballot as a short cut to political power, Richards thought women should be educated before they voted.

For Keller, method and theory constitute not separate entities but a continuum (245). She concludes that a science freed from the impulse to dominate would have a character different from the Science we revere, observing:

> if certain theoretical interpretations have been selected against, it is precisely in this process of selection that ideology in general, and a masculinist ideology in particular, can be found to effect its influence. (245-246)

We can find in the themes and activities of Richards' life an absence of the "impulse to dominate" and the presence of a strong desire to connect science with informed choice in everyday life. Besides, Ellen saw no reason why the rationality implicit in the scientific method could not be introduced into household management.

Forerunners of Applied Science in the United States

The New World offered a unique opportunity for persons of independence, energy, and intelligence to work out a new relationship with Nature and to develop a practical regard for science and technology. Boorstin (1978) remarks on how inventions reshape human lives -- especially the "common items" of everyday living:

> Those who have most influenced everyday America -- those who transformed our food, shelter, and clothing, our entertainment and information sources; those who first made a paper bag, a rotary press, a folding box, a cellophane wrapper, a picture tube, a calculating machine, or a transistor -- they rarely appear in our history books.
>
> Makers of everyday machines that remake our everyday lives have remained anonymous, partly, of course, because the inventor's work is so often collaborative, so often slowly incremental or accidental. (94)

We can see this trend taking root in the soil of the New World. In fact, science in the New World had a remarkable innovator in the person of Count Rumford of Bavaria (1753-1814). Born Benjamin Thompson in Woburn, Massachusetts, Rumford has been called "the father of technology." A man of wide-ranging interests and abilities, he was a contemporary of Benjamin Franklin. He had a distinguished career in science and diplomacy in several European countries, and he tried to persuade George III to form a public forum for the "Application of Science to the Common Purposes of Life ...." A physicist and a chemist, Rumford applied his study of heat to everyday problems such as fuels, heating, fireplaces, cooking ranges, and utensils. His research provided technical knowledge that resulted in such contemporary items as the thermos bottle and the pressure cooker. Because he used the household as his laboratory, he called his philosophy "domestic economy."

Ellen Swallow Richards recognized Rumford as the first person "to apply the term 'science of nutrition' to the study of human food, and the first to apply science to the

preparation of food materials" (Hunt, 125). Possibly because he was sympathetic to the British in the American Revolution and went to England in 1776, Rumford's contributions have been denied the place in our intellectual history that they deserve. Nevertheless, he could be considered an intellectual role model for Ellen.

A Victorian Vignette

To understand Richards' achievements, we have to retroject ourselves to the Victorian sociocultural environment. In the latter decades of the 19th century, cities were growing rapidly -- and so was pollution. The germ theory was new. Immigration created further crowding and urban blight, and the dissemination of new scientific knowledge was made difficult. Diseases ravaged populations. Opium and cocaine were common ingredients in patent medicines. Large concentrations of populations had historically created unhealthy living conditions, but now more than human and animal wastes contributed to pollution. Industrial and municipal wastes with huge concentrations of dangerous and unfamiliar chemicals were being dumped into the environment:

> There were no laws to slow the tide of filth spewing into streams, rivers, and well waters; rising thick and dark into the air; laying undrained and uncollected in the streets and yards. There was little knowledge of rudimentary sanitation and less concern for its effects. (Clarke, 72)

Basic study of the environment had become an imperative, and that required a different kind of knowledge, knowledge that connected both the natural and the human environments, and Ellen Swallow Richards was to become a crusader for such a connection. She would translate the "sense of order" achieved in a well-managed household into an "environmental principle" that could apply to a well-managed planetary home for all humanity.

MIT: Higher Education in Science and Technology

By the mid-19th century, Harvard's reputation as a preeminent site of liberal arts education was long-established. But new educational needs were emerging. In the second half of the 19th century, scientific knowledge was growing rapidly. In an era of industrialization and modernization, there was a demand for Baconian "applied science," generally scorned by the practitioners of Descartian "pure science." Harvard's "classical" curriculum was challenged, and its faculty took a dim view of the

rising importance of scientific and technical studies in a liberal arts college. The stage was set for an educational innovation that would meet the needs of a changing society. The creation of a new "institute" in Boston -- what is today the Massachusetts Institute of Technology -- presaged the dawn of a new era of modernization and industrialization in America.

Harding (1991) argues that:

> The insistence on this separation between the work of pure scientific inquiry and the work of technology and applied science has long been recognized as one important strategy in the attempt of Western elites to avoid taking responsibility for the origins and consequences of the sciences and their technologies or for the interests, desires, and values they promote. (2)

This division was as applicable to the scientific community of Ellen Swallow's time as it is today. The difference between "pure" and "applied" science was a value as strongly believed as the difference between women and men. Ellen wanted to change not just the gender make-up of science but the severance of science from life.

After again working to save money, she was finally admitted, as a nonpaying "experiment" and "special" student, to the newly established Massachusetts Institute of Technology. She was the first woman to attend MIT where, recognizing the precarious nature of her status, she kept a low -- but cooperative -- profile. Rosser (1992) reports her self-evaluation, when Ellen said of her presence at MIT, "I am useful in a decidedly general way .... They can't say study spoils me for anything else." Even before she graduated, she had carried out a pioneering project to test the sewage, streams and water supplies of Massachusetts and gained an international reputation as a water scientist (Rosser 1992, 42). She received her S.B. in chemistry from MIT in 1873. Although she received an M.S. from Vassar at the same time, opportunities to pursue an advanced degree (Ph.D.) or for professional employment were virtually nonexistent for women in the 1870s. Consequently, Swallow became an untitled, unpaid, independent scholar and researcher in the laboratories of MIT, There she was able to carve out, by her example and by her research, a niche for women in science.

In 1875 Ellen Swallow married Robert Richards, a professor of mineralogy at MIT, who had been her teacher. Their work in mineralogy and metallurgy begun in the laboratory continued in the field on their honeymoon. The

newlyweds took her husband's class on a field trip to Nova Scotia to visit the mines of the region. Her trousseau was high boots and a short skirt, a scandalous departure from Victorian images of a proper bride. After they married, a Canadian miner asked Robert to assay a copper sample. He turned the task over to Ellen. Unlike many men whose wives assisted them, her husband gave her full and unstinting credit for her important and unexpected finding: the copper ore contained five percent nickel. Based on her report, the Canadian nickel industry was born! (Clarke, 98).

Ellen's husband came from a well-connected Boston family, and the couple was able to maintain a domestic unit where future women students could find a welcoming home. The Richards' household was a meeting place for educated and enlightened men and women. Ellen Swallow and Robert Richards made a unique pair. According to Clarke:

> Apart or together, the marriage was a true symbiosis -- two lives never intruding but always an advantage to the other. She believed in the synergism of the sexes, that the sum of their relationship should be greater than its parts. This was a physical law. She saw no reason why it should not apply to social nature as well. (Clarke, 56)

In her personal as well as her professional life, Ellen Swallow Richards found it essential to live in conformity with known scientific laws!

The Development of an Ecological Conscience

Ellen Richards drew on her early experiences on a farm and as an MIT-trained chemist to study the environments in which she believed human beings flourished: the physical, the intellectual, and the moral (Clarke, 36). To be healthy in each realm required knowledge of many kinds and an understanding of the influences on their development. This led Ellen to a changing world of the mid-19th century. The Richards were scientific innovators in their own household, reflecting environmental awareness in its layout and in the design of ventilation, heating, cooking, and lighting systems -- their own Victorian "biosphere." Ellen used the kitchen of the Richards' home as a laboratory. She called her home laboratory "the Center for Right Living" (69). Ellen saw science as a grand opportunity to uplift and upgrade human life through educating women and bringing scientific knowledge into the household.

> Home and hearth and the woman who kept them together were by-passed by the Industrial

> Revolution and its new ways. She was kept from and subordinated to a rising tide of new information about a world she comprehended little and participated in less. Outstripped by new knowledge, she was less able to cope with what it produced. A new culture was emerging -- a cosmetic, mechanical culture created by man's [sic] exploitation of advancing knowledge. By detaching woman from its new processes and functions, he was creating a new environment with new human values in which the female's point of view was missing. (79)

Rapid changes in the world raised a new range of concerns. To Ellen Richards, the interface between organisms and their environment was neither mystical nor mythical; it was very real and very important. Her philosophy was that:

> The human-environment interface could be seen most clearly at its source: in the home and in the family. If the human organism is to live in harmony with the environment, it must be learned at the source. To do that, it is necessary to educate the largest half of the population: Women. (Clarke, 79)

This meant that not only women would have to be educated, but education should also be relevant for women. Given women's recognized but invisible role in household management and family life, what knowledge was essential for human improvement and wellbeing at the point of use?

Linking the Home and the Natural Environment

Ellen could not separate the "science" of the laboratory from the "science" of intelligent living in the home which then (as now) is part of the "homemaker" role, whether performed by men or women. In the *Proceedings* of the 1902 Lake Placid Conference she quotes Charlotte Perkins Stetson, "A woman does not keep house by inspiration, as was formerly thought. She keeps house 'well' only by application of intelligence and technical training. Neither does a woman take care of her children by inspiration." (*Proceedings*, 1902, 50). Ellen saw the problems of the environmental microcosm of the household as a set of independent yet interrelated problems. Women's ignorance was a major problem to be addressed through education even before suffrage was achieved. Her choice was to prioritize the personal over the political. She argued that science and technology were outstripping the home and human values to set up more serious human and environmental problems in

the future. She assailed the "false logic" that pervaded schools and she believed that scientific facts should be taught in relation to everyday life:

> We must show [that] science has a very close relation to every day life ... train [women] to judge for themselves ... to think ... to reason ... from the facts to the unknown results. (Clarke, 81)

And she continued:

> If women in general understood mechanical and physical laws, would they long endure the ... life style ... that requires coal to be shoveled down cellars only to be brought up again to the kitchen range, [then] carried back down as ashes only to be brought up again for disposal? (Clarke, 82)

She was applying the physical laws of the conservation of energy to human work -- in this case, "women's work." Her concern for pure food, air, water, and soil was the first wave in the movements that would become the consumer and the public health movements.

Health and the Environment

The relation of environmental pollution to health went unrecognized -- at home, in the streets, in businesses, and in industry. Unsanitary food production and food handling practices created opportunities for both intentional and unintentional adulteration of food on a mass scale. Transportation, food preservation methods, and refrigeration were inadequate to assure a safe food supply. According to Rosser, (1992):

> Swallow was driven in her work by her outrage over the filth and sewage in the streets and streams of Boston. She studied mineralogy and the chemistry of air to round out her vision of an environmental science encompassing earth, air, and water. (42)

By the age of 40, Ellen Swallow Richards was a world-respected scientist who advocated higher education for women -- and that included advocacy for more rigorous college preparation in science programs for girls in secondary schools, such as Girls' Latin School (1878). She was internationally recognized for her studies of samarskite, lead, copper, vanadium, and titanium. In 1879 she was elected to membership in the American Institute of Mining

and Mineralogical Engineers -- its first and only woman member (Clarke, 98).

An institution builder, she was a founder of the Association of Collegiate Alumnae (ACA) -- now the American Association of University Women (AAUW). Despite her achievements and reputation, the popular view that education was damaging to women had changed little. To Ellen, scientific investigation could contribute to changing this view. She used her influence to persuade the Commonwealth of Massachusetts to support a study of college-educated women. The survey, with the cooperation of the A.C.A., sent questionnaires to half the female college alumnae in the country. Not surprisingly, the findings, reported by the Commonwealth of Massachusetts, supported the claim that college education did not appear to be detrimental to the health of female graduates. A medical myth had been exploded (Clarke, 89).

Water Study

Water held a central place in Richards' concern for environmental quality. It was the first environment for life, the major component of the human body. Working in her Laboratory for Water Analysis -- Room 32 at MIT -- she launched water studies that continue to challenge environmentalists today. In 1887, the Massachusetts legislature authorized a statewide survey of water and sewage under the direction of recently-appointed Dr. T.M. Drown and Richards, who noted wryly that, following the death of her mentor Dr. W.R. Nichols, she was "still the number two man" (Clarke, 144). In this first great scientific survey of pollution, more than 100,000 water samples were analyzed. She herself analyzed, in whole or in part, 40,000 of them (Clarke, 145).

Richards tabulated her findings on a map of the Great Sanitary Survey. To help her analyze her findings, she "connected the dots" of areas where water chemistry was similar. These lines (isochors) began to take on a compelling configuration, much like those of today's weather maps. She had created a dramatic image of the state's water pollution. In addition to the inland water quality markers, new "coastlines" for the state were taking shape (Clarke, 145-146). When pollution points were connected, they approximated the familiar coastline of Massachusetts.

Richards "saw" something in her data. She could extrapolate from it an image of water pollution based on the amount of chlorine present in the water. From this "picture" it became feasible to determine which impurities in water were natural and which were the products of human

and industrial wastes. Thus she created the Normal Chlorine Map, still used in measuring water studies. She also created the world's first Water Purity Tables and established the first water quality standards in the United States (Clarke, 147Z). This led to her work in water and sewage treatment. She thought it "medieval" to discharge raw waste into public waters (152). She published scientific papers on "The Significance of Carbon Dioxide in Potable Waters" and "Permanent Standards of Water Analysis" (189). In 1903 she wrote, "it is hard to find anyplace in the world where the water does not show the effect of human agencies" (Clarke, 190).

Ecology: The Science of Everyone's Home

In the late 19th century, the theories of Charles Darwin (1809 -1892) and Ernst Haeckel (1834-1919) in science and the writings of H.G. Wells (1866 - 1946) were part of the *Zeitgeist*. In 1873, Haeckel, a German philosopher and biologist, dubbed a new science "oekologie," (from the Greek word *oikos*, or household) which was to be a science of "everyone's home" -- humanity's home. Haeckel, who had proposed evolutionary theories before Darwin, had coined the name for one of the "new sciences" that needed to be developed. Fluent in German, Richards had paid a visit to Haeckel's laboratories in Jena where she ordered laboratory equipment from Carl Zeiss, the famed supplier of industrial and scientific glass. Whether she met Haeckel personally is unknown. That his writings were accessible to her is certain. Ellen's purchase of the new equipment made possible new courses in biology at MIT.

Ellen Richards saw that technology was transforming the environment -- not always for the better. In 1892, she was invited to speak to the Boot & Shoe Club, made up of the leaders of New England's footwear industry, at the Club's second annual "Ladies Night." The first year's program was dedicated to the topic "Women in Higher Education." She took the occasion to propose the introduction of a new environmental science. She said:

> For this knowledge of right living, we have sought a new name .... As theology is the science of religious life, and biology the science of [physical] life ... so let Oekology be henceforth the science of [our] normal lives ... the worthiest of all applied sciences which teaches the principles on which to found ... healthy ... and happy life. (Clarke, 1972, 120)

Without making her views theoretically explicit, Richards was promoting a new paradigm for a normative science, a

science in which human values were implicit in the course of research and application. The day after her speech to Boot and Shoe, *The Boston Globe*'s headline read:

> "New Science. Mrs. Richards names it Oekology" (Clarke, 116)

Thus "pride of place" can be accorded to Ellen Henrietta Swallow Richards for having named the new science of human/environment relations "ecology" over one hundred years ago.

Ecology: The "Subversive Science"

A new course was introduced by Richards and Professor John Ordway and announced in MIT's 1876 catalogue: "Studies ... in Chemical Analysis, Industrial Chemistry, Mineralogy, and Chemistry as Related to Vegetable and Animal Physiology." By making the "connection" between the physical and biological sciences, Richards had succeeded in laying the foundations for the interdisciplinary matrix of environmental studies (Clarke, 101). Without a theoretical rationale, she had transcended the identification of Woman with Nature and what had passed for "the natural" to an understanding of the interrelationships essential for an understanding of human well-being. The study of chemistry related to vegetable and animal physiology led to the study of the foods that comprise the human diet, bringing Richards close to a science that would incorporate all the sciences that touch on human life. The support of well-connected women members of the Womens Education Association (WEA) gave Richards' experiments in curriculum support from influential women.

Ecology: An Educational Reform

On behalf of the "Massachusetts State Board of Health, Lunacy, and Charity" Richards inaugurated a study of the State's food supply, especially the staples in the household larder: flour, sugar, bread, soda, cream of tartar, and baking powders -- all of which could be analyzed chemically. These staple products were analyzed for the presence of additives that might contaminate food. She was concerned about more than the contents of the packages, however. Claims made on the packages were misleading and played on consumers' ignorance and uncertainty. The Report concluded that grocers' own brands were more reliable; price was not a measure of quality, but the absence of manufacturers' identification on the packages was a sure clue to the lack of quality inside (103). Where she could, Richards channeled future findings through popular channels so that consumers could be aware of possible contamination or

adulteration of products. Her book *The Chemistry of Cooking and Cleaning* (1882) was an immediate success. Richards was convinced of the importance of linking science to environment if ordinary people were to attain maximum health.

The Hestian Texts of Ellen Swallow Richards

I would argue that Richards' texts constitute part of the discourse of domesticity, a discourse she, like other Hestian educators before her, had tried to organize as part of women's education. She saw clearly the need to diffuse scientific information to the general public in language they could understand and in a form they could use. This was, in the language we use today, an exercise in empowerment. Scientific knowledge, methods, and findings, were not to be the sole possession of a scientific elite -- and the interests they served (industry and manufacturing) -- but of the people affected by scientific innovation in the production, distribution, and utilization of all the materials used in everyday life.

Richards' books are written in straightforward, Yankee prose. She told it like it was. But throughout her works run the combined issues of the everyday environment and the ethics of daily living. It is not hard to read Richards' books. It is hard to understand them, because so much of what she says seems so self-evident it has become part of our "common sense." What is hard to understand is the fact that she was communicating highly sophisticated empirical findings in ways that ordinary people -- women at home, especially -- could understand.

Richards had a more than passing knowledge of the work of H.G. Wells. In his book *The Discovery of the Future,* he had called for the development of a new science -- a systematic exploration of the future that could yield a knowledge of the laws of social and political development. She quotes Wells in *The Cost of Shelter* (1905), noting that "There appears to be no limit to the invasion of life by the machine" (63) and notes three of his books, published by Scribners, in her Bibliography (*Anticipation, Mankind in the Making*, and *A Modern Utopia*). She referred to "These days of unparalleled rapidity of change in industrial and social conditions" (118). In *The Art of Right Living* (1911), she calls Wells "the prophet of the New Republic."

In response to a gathering awareness of women's illness, poor health, and depression, she wrote her first book titled simply *Health*. Next came *Home Sanitation*, a compendium of environmental studies. She published her first book *The Chemistry of Cooking and Cleaning* (1882).

Air, water, and earth remained the trio that comprised Richards' interest. She recognized that "Chemical changes occur when air is taken in and exhaled from the life systems of plants and animals" (97). Life changes air just as it changes water and other elements. She studied the cycle of water use from its source, through the human community, and back to earth and ocean. A country girl, Richards had known earth as a child, filled with wonder at the fossils it contained and the crops it produced.

As early as *The Chemistry of Cooking*, Richards urged her readers to master the symbolic language of chemistry in order to demystify it. Hers was an appeal to intelligence systematically applied. She cites no less an authority than Charlemagne who said, "Right action is better than knowledge; but to act right one must know right" (84). In *The Cost of Shelter* (1905) she wrote:

> What is the value of present-day knowledge if not to stimulate the conscious group, through the individual perhaps, but the group finally, to better use its powers and opportunities toward a higher form of social life? (18)

She observed that "the boarding house began as a real family home for the homeless" (34). And she reminds her readers that James Nasmyth once wrote "Kid gloves are great non-conductors of knowledge" (42). In *The Cost of Living* (1905) Richards advocated a broad view of "sanitary science" which to her meant "a knowledge of all that physical and mental environment which leads to the highest utilization of man's powers for the progress of civilization, and not a mere study of germ diseases, [which] seems to be lacking even in the educated world" (iii). she said that "To live is to appreciate the joy of being part of the world of action, to share in the joy of work, and work for [hu]mankind; this joy includes an appreciation of the possible meaning of it all" (27). She cited Bagehot who said that "There is no pain like the pain of a new idea. What the saloon is to the drinking man, the bargain counter is to the aimless woman" (40). She wrote that "A home must mean more than four walls and food: it must stand for one's self ...." (56).

Without saying so explicitly, Richards understood the poverty of patriarchal language to express the convictions she held about the relation of environmental science to human well-being. She turned to her knowledge of ancient Greek to coin the term *euthenics* to mean "the science of right living." Richards wrote in *Euthenics* (1910) that "human life and effort are grounded largely by the conscious or unconscious value put upon the varied elements that go to make up the daily round" (106). She defined the Home

Economics movement as "an endeavor to hold the home and the welfare of children from slipping over the cliff by a knowledge which will bring courage to combat the destructive tendencies" (156). She held that the teaching of domestic economy in the elementary school and Home Economics in the high schools was intended "to give people a sense of control over their environment and to avert panic as to the future" (158).

In *The Art of Right Living* (1911), based on lectures given in 1904 in Tennessee, she sought to convince the more intelligent women that they were, to a large extent, arbiters of their own destiny on earth (5). She says, "No other living thing is so weighted with the load of mere living as is the human being" (6). She said, "production of energy is the object of life; direction of energy is another thing" (8). She conceded that while daily work should not be drudgery, most women seem not to have found the right work, and that the daily round had become deadly (27). Nevertheless, she argued that "We must accept work as part of the art of right living" (20).

When Harding (1991) says that "Women need sciences and technologies that are *for* women and that are for women in *every class, race, and culture*" so they can "learn the existing techniques and skills that will enable [them] to get more control over the conditions of their lives" and declares that the "new sciences are not to be *only* for women," and that it is time to ask "what sciences would look like that were for 'female men'" (5), she is echoing the position Ellen Swallow Richards held over a century ago. It is as true for women, for feminists, for historians of science, and for feminist historians of science that those who are ignorant of their history will be condemned to repeat it. There is, in the literature, a serious failure to take into account the pioneering work of Ellen Swallow Richards -- this recognized "ecological foremother" and "Mother" of environmental science -- as a woman who applied her scientific education, knowledge, and international reputation to advance ecological/environmental study in the name of "Oekologie," "domestic science," and Home Economics.

As Harding argues:

> Feminism insists that questions be asked of nature, of social relations, and of the sciences different from those that "prefeminists" have asked, whether conventional or countercultural. How can women manage their lives in the context of sciences and technologies designed and directed by powerful institutions that appear to have few interests in creating social relations beneficial

> to anyone but those in the dominant groups. (1991, 5-6)

These words have a powerful ring of truth -- they "resonate" -- to a feminist home economist. However, the obscured history of a scientifically-based curriculum designed to assist women (*and* men) to "manage their lives in the context of science and technologies" is found in the Home Economics movement since its inception at the end of the 19th century. I would offer my own texts of two decades ago to support this claim (Paolucci, Faiola & Thompson, 1973, 1978).

Reflecting on Richards

In one of the first books dealing with women's contributions to science, H.J. Mozans (a pseudonym for John Augustine Zahm, a Roman Catholic priest who headed a small Indiana congregation) chronicled their neglected history (1913. Rpt. 1974). Dating his study back to the intellectual contributions of women in Greece, he observed, "Every advance toward the goal of social and intellectual equality was strenuously contested by the men, who wished to limit the activities of their wives to the spindle, the distaff and the loom and other occupations of the household" (19). Mozans saw the value of women's scientific knowledge in making them better able to care for and educate their children. In reporting on contemporary women scientists, Mozans notes that chemist Ellen Swallow Richards, eager to devote her life to the pursuit of science, resolved to apply the knowledge she gained to the problems of daily life. He wrote:

> She saw, among other things, the necessity of a complete reform in domestic economy, and resolutely set to work to have her views adopted and put into practice. She was ... one of the first leaders in the crusade in behalf of pure food .... She was likewise one of the first to apply the science of chemistry to an exhaustive study of the science of nutrition .... To her the kitchen was the center and source of political economy. (217-218)

Mozans says that to Richards the facts of science were more than uncorrelated facts, and she held this perspective over the 27 years during which she held the post of instructor of sanitary chemistry at M.I.T. Recognized as an authority on air, water, and sewage analysis, Richards used science as a platform from which to promote many programs related to public health.

Sue V. Rosser also summarizes Richards' contributions:

> Ellen Swallow Richards went on to lay the groundwork for the science that the German biologist Ernst Haeckel defined in 1873 as *oekologie* -- the study of organisms in their environment. She pioneered the testing of air, water, and soil for pollutants. Because of her concern for how the human organism lives in an environment of rapid industrialization, some students of history, notably the environmental engineer H. Patricia Hynes of MIT, consider her the founder of environmental science -- as well as a founder of ecology. But today, if she is remembered at all, she is thought of as the founder of home economics; credit for founding ecology goes to Haeckel. (Rosser, 1992, 43)

In the paragraph that follows the one that opens this paper, Richards' biographer concluded:

> Without Ellen [Richards'] work, Rachel Carson might never have had access to the knowledge she passed on to alert us. Two of the three schools from which Rachel Carson obtained that knowledge had felt the definite influence of the woman who founded environmental science: Johns Hopkins and Woods Hole Marine Laboratory. (Clarke, 255)

As contemporary scholars attempt to bring coherence to the accumulating body of feminist work and to infuse it with human values, they will approach the point that Ellen Richards reached at the end of her life, namely her vision of what Dean Sarah Arnold of Simmons College called "an entirely new discipline."

I would argue that Richards' conception of Home Economics was a radical educational project that challenged patriarchal epistemological assumptions and contained a vision of a "new" discipline which would build a more sustainable environment by introducing rationality to household operations. This explains why some Home Economics departments have changed their names to Human Ecology.

It might further be argued that Richards' original insights represent what Davis, following Arne Naess, characterizes as *ecosophy*, a term derived from the feminine Greek word for wisdom (155). As Davis explains:

> Sophia denotes something beyond the ordinary realm of empirical experiences, eluding scientific, rational, and even diachronic interpretations or

> hermeneutics. Sophia goes beyond science and art alone (156).

After some points that I, as a feminist, would feel compelled to dispute, Davis says that "women have found the masculine emphasis upon language, logic, and the verbal and written arts incomplete and one-sided" (156, note omitted). He concludes:

> The Western world ... must reopen its eyes to an entirely different way of perceiving the environment. To embrace Sophia as an epistemological equal is to rekindle the dying embers of the feminine fire within each of us. (162. Note omitted. Emphasis supplied.)

Thus the Sophia archetype is unconsciously linked (in Davis' metaphor of the "dying embers of the feminine fire") to Hestia, goddess of the hearthfire -- of the *oikos*, the household, the home -- of that element or fundamentally androgynous principle that is the originary concept of our contemporary ideas of economics and ecology. It is these ideas that deserve epistemological equality in our educational programs and everyday discourse.

In a state of the art review, Sandra Harding (1991) maps the feminist discourse territory with respect to androcentric science and critiques three epistemological approaches: (1) feminist empiricism which identifies only "bad science" as the problem, (2) the feminist standpoint, which argues that women's social experience provides a unique starting point for the discovery of masculinist bias in science, and (3) postmodernist feminism which challenges the most basic scientific assumptions. Harding argues for the infusion of feminist values and attitudes in science to remove gender and race bias. The challenge to androcentric assumptions, hypotheses, and interpretations deserve critical scrutiny. The selective focus based on the assumption that the "male" standpoint is the universal "human" standpoint is now an accepted criticism of male disciplines. Pushing this argument to its extremes involves paradigm change. In this, Richards was a first. Her "standpoint" was ecological. [1]

NOTE

1. As a testament to Ellen Richards' prescience, a report issued in mid-January, 1994 by the Worldwatch Institute says that slowed growth in world food supplies provides evidence that global biological limits may have been reached. In its 11th annual "State of the World" report, the environmental

group said that signs of this include rising world rice prices, millions of acres of now useless rangeland, and spreading water shortages. For two decades scientists have been saying that the world hunger crisis can be solved by increasing crop yields and improving food distribution. But this report takes a different view. It says that *family planners hold the key to future food supplies* (The *New York Times*, January 14, 1994, 6. Emphasis supplied).

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MARIA MITCHELL

1818–1889
Established the Vassar College Observatory in the U.S., one of the earliest and most important astronomy programs for women. In 1847 Mitchell, who learned astronomy from her father and her own reading, received widespread acclaim for the discovery of a comet.

ELLEN SWALLOW RICHARDS

1842–1911
Engineer lauded as the "woman who founded ecology." Richards, denied a deserved Ph.D. in chemistry at the Massachusetts Institute of Technology, was the first woman to be elected to the American Institute of Mining and Metallurgical Engineers.

Maria Mitchell was Ellen Swallow's mentor when she was at Vassar.

Ellen Swallow Richards with her colleagues at MIT in 1900.